

Clusters

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Introducing Clusters Computing

- A computer cluster is a group of tightly coupled computers that work together closely so that it can be viewed as a single computer.
- Clusters are commonly connected through fast local area networks.
- Clusters have evolved to support applications ranging from e-commerce, to high performance database applications.

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Cluster Computers in view



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Cluster Computing

A group of interconnected WHOLE COMPUTERS works together as a unified computing resource that can create the illusion of being one machine having parallel processing.

The components of a cluster are commonly, but not always, connected to each other through fast local area networks.

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What's Whole Computer

- A system that can refer run on its own apart from the cluster; used in server systems are called whole computers.



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Why is Clusters than single 1's?

- Price/Performance
The reason for the growth in use of clusters is that they have significantly reduced the cost of processing power.
- Availability
Single points of failure can be eliminated, if any one system component goes down, the system as a whole stay highly available.
- Scalability
HPC clusters can grow in overall capacity because processors and nodes can be added as demand increases.

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Where does it matter?

- The components critical to the development of low cost clusters are:
 - ❖ Processors
 - ❖ Memory
 - ❖ Networking components
 - ❖ Motherboards, busses, and other sub-systems

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Short History ...

- The first commodity clustering product was ARCnet, developed by Datapoint in 1977.
- The next product was VAXcluster, released by DEC in 1980's.
- Microsoft, Sun Microsystems, and other leading hardware and software companies offer clustering packages.
- But Linux is the most widely used operating systems ever since for cluster computers around the world.

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IBM hidro Clusters



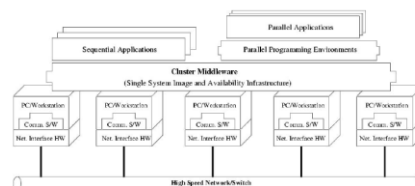
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Clusters Architecture

- A cluster is a type of parallel /distributed processing system, which consists of a collection of interconnected stand-alone computers cooperatively working together a single, integrated computing resource.
- A node:
 - ❖ a single or multiprocessor system with memory, I/O facilities, & OS
 - ❖ generally 2 or more computers (nodes) connected together
 - ❖ in a single cabinet, or physically separated & connected via a LAN
 - ❖ appear as a single system to users and applications
 - ❖ provide a cost-effective way to gain features and benefits

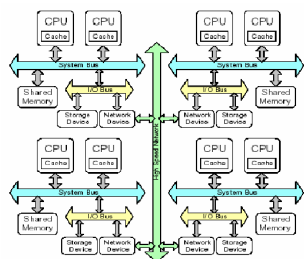
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Architecture of Clusters



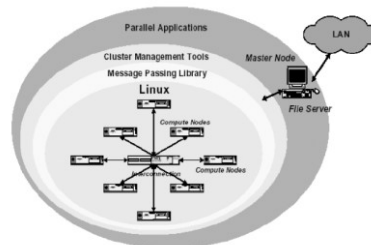
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How Clusters works?



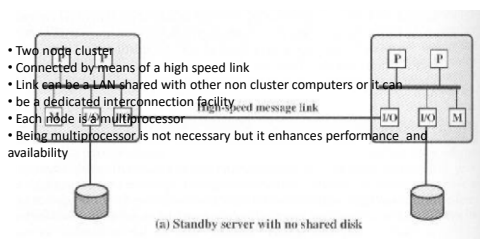
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A logical view for clusters



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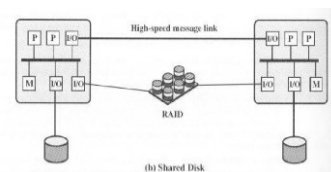
Configuration Of Figure A



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Configuration of figure B

Shared disk cluster
 Message link between nodes
 Also, there is a disk subsystem directly linked to multiple computers within the cluster
 Common disk subsystem is a RAID
 RAID is used so that high availability is not compromised by a shared disk that is a single point of failure



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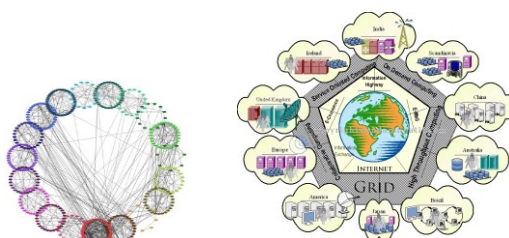
Clustering Methods

CLUSTERING METHOD	DESCRIPTION	BENEFITS	LIMITATIONS
Passive standby	A secondary server takes over in case of primary server failure	Easy to implement	High cost because the secondary server is unavailable for other processing tasks
Active standby	The secondary server is also used for processing tasks	Reduced cost because secondary servers can be used for processing	Increased complexity
Separate servers	Separate servers have their own disks. Data are continuously copied from primary to secondary server	High availability	High network and server overhead due to copying operations
Servers connected to disks	Servers are cabled to the same disks, but each server owns its disk. If one server fails, its disks are taken over by the other server	Reduced network and server overhead due to elimination of copying operations	Usually requires disk mirroring or RAID technology to compensate for risk of disk failure
Servers share disks	Multiple servers simultaneously share access to the disks	Low network and server overhead. Reduced risk of downtime caused by disk failure	Requires lock manager software. Usually used with disk mirroring or RAID technology

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Cluster Catagorization

- High-availability (HA)
- Load-balancing
- High- Performance(HP)



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High Availability Clusters

- Avoid single point of failure
- This requires atleast two nodes - a primary and a backup.
- Always with redundancy
- Almost all load balancing cluster are with HA capability.



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Load Balancing Clusters

- PC cluster deliver load balancing performance
- Commonly used with busy ftp and web servers with large client base
- Large number of nodes to share load



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High Performance Clusters

- ❖ Start from 1994
- ❖ Donald Becker of NASA assembled this cluster.
- ❖ Also called Beowulf cluster
- ❖ Applications like data mining, simulations, parallel processing, weather modeling, etc.



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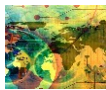
Issues to be considered about

- Cluster Networking
- Cluster Software
- Programming
- Timing
- Network Selection
- Speed Selection

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Cluster Networking

- Huge difference in the speed of data accessibility and transferability and how the nodes communicate.
- Just got to make sure that if it's in your budget then the clusters have the similar networking capabilities and if possible, then buy the network adapters from the same manufacturer.



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Cluster Software

- You will have to build versions of clustering software for each kind of system you include in your cluster.



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Programming

- Our code will have to be written to support the lowest common denominator for data types supported by the least powerful node in our cluster. With mixed machines, the more powerful machines will have attributes that cannot be attained in the powerful machine.



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TiminG

➤ Timing

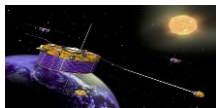
This is the most problematic aspect of cluster. Since these machines have different performance profile our code will execute at different rates on the different kinds of nodes. This can cause serious bottlenecks if a process on one node is waiting for results of a calculation on a slower node..

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Network Selection

▪ Network Selection

There are a number of different kinds of network topologies, including buses, cubes of various degrees, and grids/meshes. These network topologies will be implemented by use of one or more network interface cards, or NICs, installed into the head-node and compute nodes of our cluster.



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Right Speed Selection

▪ Speed Selection

No matter what topology you choose for your cluster, you will want to get fastest network that your budget allows. Fortunately, the availability of high speed computers has also forced the development of high speed networking systems.

▪ Examples are :

10Mbit Ethernet, 100Mbit Ethernet, gigabit networking, channel bonding etc.

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Implementation of Clusters

- The TOP 500 organization's semi-annual list of the 500 fastest computers usually includes many clusters.
- As of June 18, 2008, the top supercomputer is the Department of Energy's IBM Roadrunner system with performance of 1026 TFlops measured with High-Performance LINPACK benchmark.
- Clustering can provide significant performance benefits versus price. The System X supercomputer at Virginia Tech.

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Implementation of Clusters

- the 28th most powerful supercomputer on Earth as of June 2006, is a 12.25 TFlops computer cluster of 1100 Apple XServe G5 2.3 GHz dual-processor machines (4 GB RAM, 80 GB SATA HD) running Mac OS X and using InfiniBand interconnect.
- The total cost of the previous Power Mac system was \$5.2 million, a tenth of the cost of slower mainframe computer supercomputers. (The Power Mac G5s were sold off.)
- The central concept of a Beowulf cluster is the use of commercial off-the-shelf (COTS) computers to produce a cost-effective alternative to a traditional supercomputer. One project that took this to an extreme was the Stone Soupercomputer.

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Implementation of Clusters

- clusters are excellent for parallel computation, but much poorer than traditional supercomputers at non-parallel computation.
- JavaSpaces is a specification from Sun Microsystems that enables clustering computers via a distributed shared memory.
- gridMathematica - computer algebra and 3D visualization.
- High powered Gaming.

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Cluster Technologies

- MPI is a widely-available communications library that enables parallel programs to be written in C, Fortran, Python, OCaml, and many other programming languages.
- The GNU/Linux world supports various cluster software; for application clustering and etc.
- Microsoft Windows Compute Cluster Server 2003 based on the Windows Server platform provides pieces for High Performance Computing. This cluster debuted at #130 on the Top500 list in June 2006.

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Conclusion ...



- Clusters are promising
- ❖ Solve parallel processing paradox
- ❖ New trends in hardware and software technologies are likely to make clusters.
- ❖ Clusters based supercomputers (Linux based clusters) can be seen everywhere !!!

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Thank you so much ...

Is there any further query regarding clusters?

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